SCB-0006

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	B. Martinez-Tovar, et al)	Group Art Unit: 3641
Serial No:	09/470,343)	Examiner: T. Chambers
Filing Date:	December 22, 1999)	
Title:	TITANIUM SEMICONDUCTOR BRIDGE IGNITER)	

DECLARATION TRAVERSING REJECTION, SUBMITTED UNDER RULE 1.132

I, Bernardo Martinez-Tovar, hereby declare as follows:

1. I am the inventor named in the subject patent application.

2.(a). My educational and professional training and experience in the field of electrical igniters for reactive materials is summarized in the *curriculum vitae* attached hereto as Exhibit A

I have been an employee of SCB Technologies, Inc. for 12 years as a research and development engineer and product designer in the field of igniters for reactive materials.

(b). I am also named as an inventor in four issued U.S. patents in the field of semiconductor bridge igniters: U.S. patent 6,199,484; U.S. patent 6,133,146; U.S. patent 6,054,760; and U.S. patent 5,992,326.

3. I have reviewed the claims 1-4, 6-9, 11, 15, 16, 35 – 37 and 40-58 being submitted herewith in the captioned application, the office action dated October 6, 2005, my earlier Patent Cooperation Treaty (PCT) patent application, WO 9742462 ("the PCT application"), U.S. Patent 4,976,200 to Benson et al. ("the Benson et al. patent") and the

attached translation of German patent document DE 4 222 223 to Brede et al. ("the Brede et al. patent"), all of which are referred to in the office action as prior art.

4. Each of the pending independent product claims (claims 1, 36, 53 and 54) pertain to an igniter comprising a bridge structure on a substrate, wherein the bridge structure comprises a semiconductor material and layer of titanium on the semiconductor material without a layer of tungsten on the semiconductor bridge. Method claims 40 and 55 define a method of operation of such an igniter.

5.(a). Claims 18 and 35 – 40 have been rejected on the basis that they are anticipated by the PCT application. However, the PCT application only discloses igniters having a layer of tungsten as well as titanium on a semiconductor bridge. By excluding a layer of tungsten from the product claims, I believe that the claims will be patentably distinguishable from what is disclosed in the PCT application.

(b). Method claims 40 and 55 define methods of operation that do not occur with a titanium-and-tungsten bridge igniter as shown in the PCT application because of the high melting temperature of tungsten. Therefore, the igniter described in the PCT application cannot first melt the metal layer on the semiconductor bridge and then vaporize the bridge as required in claims 40 and 45.

6. Claims 1-4, 6-9, 11, 15, 16, and 35- 40 have been rejected on the basis they are an obvious combination of Benson et al. and Brede et al., alleging that it would be obvious to use the titanium bridge shown by Brede et al. in place of the tungsten in the Benson et al. igniter.

7. The Benson et al. patent discloses an igniter ("the Benson et al. igniter") that comprises a bridge structure on a substrate. The bridge structure comprises a semiconductor bridge over which is disposed a layer of tungsten. The semiconductor bridge is deposited on the substrate subject to configurational limitations to determine the electrical properties of the bridge (see column 4, lines 23-28). In contrast, the tungsten is applied by a selective chemical vapor deposition process without the need for masking to

define its shape (see column 4, lines 15-21). This tungsten is clearly not limited to a bridge configuration, but rather blankets the semiconductor bridge and a substantial, undefined area adjacent to the bridge. In use, the tungsten initially conducts the electric current of the initiation signal until it heats the semiconductor material beneath it to its intrinsic conducting temperature. At that point, the ohmic resistance of the semiconductor bridge is less than that of the tungsten, so prior to initiation, the semiconductor material diverts current from the tungsten until a plasma that can initiate a reactive material is formed from both the tungsten and the semiconductor material (see column 4, lines 52-62 and column 5, lines 38-50). Thus, at the moment of initiation, the tungsten is not the principal conductor of firing current in the igniter device, and the energy requirements of the igniter are reduced, which contributes to the low energy requirements desired by Benson et al. (see column 4, lines 65-68).

8. The Brede et al. patent is cited for disclosing an igniter having a bridge (132) that consists of titanium with no semiconductor material beneath it. Instead, the titanium is disposed directly on a ceramic substrate (114). In use, an electrical current flows through the titanium bridge and heats the titanium, which in turn heats and thus initiates the pyrotechnical material resting against it. Brede et al. give no indication that the bridge structure forms a plasma to initiate the pyrotechnic material. In the disclosed mode of operation, the resistance of the titanium bridge and, therefore, the energy requirements of the igniter, increases during use until the igniter functions, because titanium has a positive thermal coefficient of conductivity.

9. To one of ordinary skill in the art of initiators for reactive materials, the combination of teachings from Benson et al. and Brede et al. as proposed by the Examiner, i.e., the use of the titanium bridge of Brede et al. on the semiconductor bridge of Benson et al., would not have been an obvious one at the time I made the claimed invention. The Examiner's reasoning behind the obviousness rejection, as set forth in the office action, is faulty for reasons discussed in paragraphs 10(a) and (b) herein, and the proposed combination is not obvious for other reasons discussed in paragraphs 11 and 12 herein.

10.(a). The Examiner asserts that it would be obvious to replace the tungsten shown in the Benson et al. igniter with the titanium shown in the Brede et al. igniter, to obtain a bridge that is resistant to damage. This motive would not occur to one of ordinary skill in the art because it is known that tungsten as shown by Benson et al. is a refractory metal while titanium is not and, therefore, tungsten is more resistant to scratches and other mechanical damage than titanium. Additionally, Brede et al. require the titanium to be limited to a bridge configuration, which is a vulnerable configuration, whereas Benson et al. do not configure the tungsten in that way. Thus, the physical configuration of the metal on the Benson et al. bridge is more resistant to damage than the metallic bridge of the Brede et al. igniter. Furthermore, Benson et al. disclose a selective vapor deposition technique for depositing the tungsten layer on silicon, but that technique was not available for titanium at the time I made the invention I claim in the subject application. Accordingly, the proposed substitution would not appear to serve the motive asserted by the Examiner as a basis for rejecting the claims.

(b). The Examiner also asserts that it would be obvious to employ the titanium shown by Brede et al. on the semiconductor bridge of Benson et al. to attain the advantageous thermal coupling reported by Brede et al. due to the large surface area of the titanium bridge. However, the Benson et al. igniter does not operate on heat transfer from the metal layer on the bridge to the reactive material as does the Brede et al. igniter, but rather by the formation of a plasma by the semiconductor material, so the asserted motive of providing good thermal coupling between a metal bridge and the pyrotechnic material as promoted by Brede et al. is inapposite to the Benson et al. igniter. Furthermore, Brede et al. teach that the titanium bridge be disposed directly on an insulating substrate, which helps focus heat transfer from the titanium bridge to the pyrotechnic material, whereas Benson et al. show the tungsten on a semiconductor material that absorbs heat from the tungsten to attain the intrinsic conducting temperature to foster the formation of the required plasma. Putting titanium on a heat-absorbing bridge would be contrary to the teachings of Brede et al., thus weighing against the proposed combination. Finally, even if thermal coupling were a concern in the Benson et al. igniter, the tungsten disclosed by Benson et al. is not limited to a bridge structure as is

the titanium shown by Brede et al. Therefore, contrary to the Examiner's position, it does not appear that providing the titanium bridge disclosed by Brede et al. would improve the thermal coupling in the Benson et al. igniter. In fact, since the tungsten layer of the Benson et al. igniter is apparently thinner than the semiconductor bridge beneath it, limiting the metal layer to a titanium bridge as shown by Brede et al. would probably decrease thermal coupling in the Benson et al. igniter, rather than increase it, because a titanium bridge would have to be thicker than a tungsten bridge to attain the same electrical characteristics due to the higher electrical resistivity of titanium relative to tungsten. The increased thickness of the titanium would cause the bridge to absorb more heat than a corresponding tungsten bridge, leaving less energy to heat the semiconductor beneath it and thus increase the energy requirement for its reliable function - a result that would militate against the proposed combination. As a result, the proposed substitution would detract from the function of the Benson et al. igniter in a manner contrary to a stated advantage of the Benson et al. device: low energy consumption. For this reason, the Examiner's proposed combination would not have been obvious and is contrary to the teachings of the references themselves.

11. (a). Aside from the Examiner's errors mentioned above, the proposed combination would not be obvious because the structure and mode of operation of the Brede et al. igniter differ from those of the Benson et al. igniter in the following ways.

(b). The Brede et al. igniter operates by heat conduction from the bridge structure to the pyrotechnical material in contact therewith. The heat is generated solely by the flow of electricity through the titanium bridge. For this reason, Brede et al. emphasize that the ignition bridge has high heat conductivity and a large surface area by which heat is transferred to a large number of priming charge crystals. See the attached translation of DE 42 22 223 (EXHIBIT B), at page 4. The Brede et al. initiator operates with increasing bridge resistance and increasing energy requirements up to initiation.

(c). In contrast, the Benson et al. igniter operates on the basis that tungsten and the semiconductor material bridge interact with each other to generate a plasma that initiates a reactive material, with a reduction in resistance and a decrease in energy requirements just prior to initiation.

(d). The diverse modes of operation of the Brede et al. igniter and the Benson et al. igniter defeat the obviousness of the combination of teachings put forth by the Examiner. Specifically, it would not have been obvious to replace the layer of tungsten shown by Benson et al. with the layer of titanium shown by Brede et al. because the titanium bridge disclosed by Brede et al. can not be selectively vapor deposited on a semiconductor material and does not generate a plasma to initiate the reactive material, and Brede et al. do not teach that titanium would be capable of heating a semiconductor bridge to generate a plasma to initiate the pyrotechnical material. In addition, the energy requirements of the Brede et al. igniter increase just prior to initiation, due to the temperature-induced increase in bridge resistance, whereas the Benson et al. igniter experiences a reduction in energy requirements, and Benson et al. favor low energy consumption. Therefore, the proposed combination would either deprive the Benson et al. igniter of its mode of operation (the formation of a plasma from semiconductor material) or require that the titanium function in a significantly different way and under significantly different conditions from what Brede et al. disclose (with titanium resting directly on a thermally absorbing semiconductor bridge beneath it rather than an insulating ceramic substrate). The combination would also require the titanium to function under significantly different conditions from that in the Brede et al. igniter, i.e., with a thermally absorbing semiconductor material beneath it rather than an insulating substrate. Such an arrangement would be counter-productive in the context of Brede et al. igniter, which requires heat transfer from the titanium to the reactive material. Therefore, the proposed combination could only be expected to function, if at all, subject to a significant change not only in the method of fabricating the bridge structure but in the basic mode of operation of one or the other of the references.

12. For the reasons set forth in paragraphs 10(a), 10(b) and 11(a)-(e), a person of ordinary skill in the art would not have considered it obvious in view of U.S. Patent 4,976,200 to Benson et al. ("the Benson et al. patent") and German patent document DE 4 222 223 to Brede et al. ("the Brede et al. patent") to produce an igniter having a semiconductor bridge with a layer of titanium without a layer of tungsten at the time I made this invention, as defined in the claims currently pending in this application,.

Furthermore, the prior art did not support a reasonable expectation that a semiconductor bridge igniter with a layer of titanium without a layer of tungsten would actually function under any mode of operation, if made. For these reasons, the rejected claims define a patentable distinction over these references.

13. The method defined by claim 40 is not obvious from either the Benson et al. patent, the Brede et al. patent, or a combination of the two. Claim 40 requires the melting of the metal on the semiconductor bridge, followed by vaporizing the semiconductor bridge. Neither Benson et al. or Brede et al. disclose or suggest such a process, explicitly or implicitly. The tungsten on the bridge of Benson et al. is a refractory metal that would not melt before the plasma is formed. The Brede et al. igniter lacks any semiconductor material in a bridge, so the titanium cannot melt before a bridge vaporizes. Furthermore, the Brede et al. igniter initiates reactive material by heat transfer from the titanium bridge, which can be expected to occur at temperatures of about 300°C to about 600°C, which are below the melting temperature of titanium, so one of skill in the art would not expect the titanium to melt before the reactive material ignites. Nowhere does either reference suggest melting the metal on a semiconductor bridge and then vaporizing the semiconductor bridge, as defined in claim 40.

14. The Examiner's comment on the use of a degree symbol with "K" to indicate absolute temperature in the Kelvin scale is not absolutely correct, in that K is commonly used with a degree symbol.

15. The Examiner's comments regarding the plasma temperature reported by Baginski are not properly applicable to the claims because Baginski was describing the temperature of a plasma already formed, and because the temperature of a plasma is that of electrons and other sub-atomic particles; not that of a vaporized metal or the temperature of the surface of a layer of metal on an igniter bridge. A typical example of this difference is a hot plasma generated by an electro-static discharge, i.e., ionized air, when a person approaches a metallic object after walking on a carpet; versus a red glowing tungsten filament of a light bulb. From this basic comparison it is obvious to

infer that the temperature of a hot plasma, as that one generated by the semiconductor bridge, will not be able to melt, and much less to vaporize, a layer of tungsten material on the bridge. Therefore, the claimed invention provides for a significant energy savings in the formation of the plasma, by the exclusion of tungsten from the bridge structure and elimination of the need for extra energy to melt and vaporized it.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Bernardo Martinez-Tovar

Date: January 6, 2006

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EXHIBIT A

SERIAL NO: 09/470,343

Bernardo Martinez-Tovar **Curriculum Vitae (2005)**

Educational Background

1986-1992 The University of New Mexico Albuquerque, NM

- Ph. D., in Electrical Engineering / Semiconductor Physics and IC Design and Processing. Doctoral dissertation was defended in December 1992 and Ph. D. degree awarded in May 1993.

1983-1986 National Institute of Astrophysics, Optics and Electronics Tonantzintla, Puebla, MEXICO

- M.S., Semiconductor Physics and IC Design and Processing.

1979-1983 Autonomous University of Puebla, Puebla, MEXICO

- B.S., Electronics and Physics

Started investigating and studying the Semi-Conductor Bridge (SCB) technology when this last had just been transferred to The University of New Mexico from the Sandia National Laboratories in 1987.

Expertise

For the last 15 years, my professional career has been focused mainly on creating new concepts for improving the initiation of energetic materials with SCB-based initiators. By putting together my experience in semiconductor physics and device fabrication with the need to solve challenging issues in the world of reactive materials, I have been able to create and patent other type of SCB initiator. I have also had the opportunity, over the years, of exploring and understanding other type of electrical igniters such as hot wires, metal bridges, reactive bridges, slappers, and foils. Over the years, my expertise in the field of electrical initiators has also had a direct and positive impact in government related projects and applications as close collaboration with US National Laboratories and Private Companies has resulted in the continuous development and manufacturing of new SCB chip designs. At present, one of my challenging tasks is the development of an automotive air bag initiator that would be sufficiently safe for handling in an assembly environment and yet reliable enough for functioning with very low energy when commanded.

Work Experience

1995-2005 The Ensign-Bickford Industries-SCB Tech. Inc. Albuquerque, NM

Position: Technical Manager.
Responsibilities:

- Management of personnel.
- Supervising the technical side of SCB Technologies, Inc.
- Advancing the SCB technology to a more energy efficient and economical level of application by creating new out-of-the-box ideas and patents.
- Technical and Direct Support to customers such as:
- Sandia National Laboratories,
- Lawrence Livermore National Laboratories.
- Halliburton Energetic Services.
- Dyno-Nobel Initiation Systems.
- Elton Thiokol Corporation.
- Pacific Scientific.
- The Ensign Bickford Industries.
- Naval Surface Warfare Center - Indian Head.

1993-1995 SCB Technologies, Inc. Albuquerque, NM

Position: R&D Engineer.
Responsibilities:

- Research and development of more advanced and reliable SCB chip initiators.
- Overseeing mass production of SCB chips.
- SCB product testing and certification.
- Computer layout design of customer-oriented SCB chips.
- Technical support to customers:

1989–1993 The University Of New Mexico.Albuquerque, NM

- Design, fabrication, and characterization of Bipolar, MOSFET, and Discrete semiconductor devices.
- Study and development of wafer processing techniques to mass produce Bipolars, MOSFET, and SCB devices, including, but not limited to...
  - Thermal diffusion and oxidation in Silicon.
  - Physical deposition of metals; Thermal evaporation, Sputtering, Plating…etc.
  - Lithography Techniques.
  - Plasma Etching; Characterization and Optimization.
  - Anisotropic Chemical Etching in Silicon.
- Study of 1-Dimentional " Electro-Thermal " effects of SCB chips as a function of electrical stimulus and physical parameters.

- Computer Modeling of Electro-Thermal Transients in SCB devices.
- Firing of inert SCB initiators for understanding initiator's characteristics as a function of input pulse and semiconductor thermal and electrical properties. Experimental work done (1990-1992) at Sandia National Laboratories under supervision of Robert W Bickes, Jr., Co-inventor of the first SCB igniter, Patent No.: US 4,708,060
- Visible Light Emission in Silicon p-n junctions; Device processing and characterization.

Patents Granted

- U.S. 6,199,484 March 13, 2001
  "Voltage-Protected Semiconductor Bridge Igniter Elements"
- U.S. 6,133,146 October 17, 2000
  "Semiconductor Bridge Device And Method Of Making The Same"
- U.S. 6,054,760 April 25, 2000
  "Surface Connectable Semiconductor Bridge Elements And Devices Including The Same"
- U.S. 5,992,326 November 30, 1999
  "Voltage-Protected Semiconductor Bridge Igniter Elements"

Publications

- U.S. 2004/0261645 A1 December 30, 2004
  US Patent Application Publication for "Tubular Igniter Bridge"
- "GEOSEIS Seismic Blast Initiation System," R&D 100 Awards, Year 1997.
- "Measurement of Plasma Electron Density Generated by a Semiconductor Bridge", Electronic Letters, vol. 34, no. 7, pp603-4, March 1994
- "Raman and Photoluminescence Characterization of Mesoscopic Si Grating", Contributing Paper at IQEC-1994
- "A Scalable Si Nanofabrication Technology," Invited Paper to CLEO-1994.
- "Si Nanostructures; Fabrication and Physics," Submitted to J. Electroch. Soc. Conference held at Miami Beach, FL. October 9-14, 1994.
- "Room Temperature Photoluminescence Measurements from Crystalline Si Nanostructures," OSA Annual meeting at Dallas, TX, Oct. 2-7, 1994.
- "Electrothermal Transients in Highly Doped Phosphorous Diffused Silicon-On-Sapphire Semiconductor Bridges (SCB) under High Current Density Conditions," Doctoral Dissertation, The University of New Mexico, May 1993.
- "Asymmetry Tilt Boundaries in Generalized Boundaries," Phys. Rev. Lett., vol. 61, no. 23, pp. 2681-4.
- "Formation of Buried Nitride Layers in (110) Silicon," Silicon-On-Insulator and Buried Metals in Semiconductors; Symposium, Boston MA, USA, (Mat. Res. Soc. 1988) pp. 461-6

- "Kinetics of Silicon Nitride crystallization in N^{+}-Implanted Silicon," J. Mater. Res., Vol. 4, no. 2, pp. 394-398 (1989)
- "Coherent Precipitation of Silicon Nitride in Si," Appl. Phys. Lett., Vol. 52, no. 21, pp. 1782-4.

SCB-0006

Ser. No. 09/467,353

EXHIBIT B

Technical Language Service

Translations From And Into Any Language

GERMAN / ENGLISH TRANSLATION OF

Source: German patent DE 42 22 223 C1

Title: Electrical Igniter-Fuse

Your Reference No.: SCB-0006

For: Cantor Colburn LLP

Requester: Frederick Spaeth, Esq.,
Jackie Boya

DE4222223

Publication Title:

Electrical igniter-fuse with insulating supporting body - has Titanium@ or Titanium-nitride igniter bridge joining contacts

Abstract:

The electrical igniter-fuse has an insulating carrying body (114) supported by two contacts (128,130) joined by an igniter bridge (132). The bridge is of titanium, titanium nitride, or an alloy consisting mainly of titanium, typically pure titanium. The contacts and bridge can be in one piece and of the same material, or the former can be of a material of lower specific resistance than titanium. USE/ADVANTAGE - For firing multiple demolition or blasting charges simultaneously, giving a high degree of reliability. Igniter bridge has improved mechanical characteristics. Less sensitive to scratches and chaffs.

SCB-0006

(19) Federal Republic of Germany

German Patent Office

(12) **Patent**

(51) Int. Cl.^{5}:
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(11) **DE 42 22 223 C1**

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(45) Publication of patent granting: March 17, 1994

An opposition can be filed within 3 months of publication

(73) Patent holder:

Dynamit Nobel AG, 53840 Troisdorf, DE

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von Kreisler, A., Dipl.-Chem.; Selting, G., Dipl.-Ing.; Werner, H., Dipl.-Chem. Dr.rer.nat.; Fues, J., Dipl.-Chem. Dr.rer.nat.; Böckmann gen. Dallmeyer, G. Dipl.-Ing.; Hilleringmann, J., Dipl.-Ing.; Jönsson, H.,Dipl.-Chem.. Dr.rer.nat.; Meyers, H., Dipl.-Chem. Dr.rer.nat., Patent attorneys, 50667 Köln [Cologne]

(72) Inventors:

Brede, Uwe, Dipl.-Ing. (TU), 8510 Fürth, DE; Cornelius, Heinz-Peter, 8534 Wilheremsdorf, DE; Häring, Oskar, 8501 Grosshabersdorf, DE; Kordel, Gerhard, Dipl.-Ing. (FH [Technical College]), 8500 Nürnberg, DE

(56) Documents considered for the evaluation of patentability:

DE-PS 20 20 016
EP 01 20 176 B1
NEUMÜLLER, Otto-Albrecht: Römmpp's Lexicon of Chemistry, 8th edition, Vol. 6, T-Z, Stuttgart, Franckhsche Verlagshandlung, 1988, pages 4276-4282, ISBN 3-440-04516-1;

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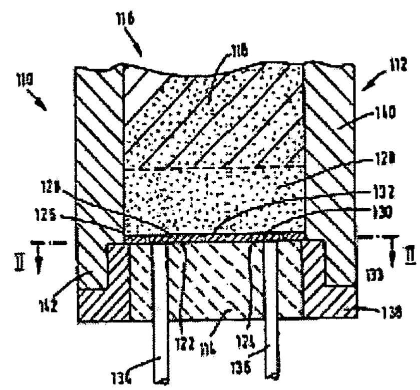
(54) Electrical Igniter-Fuse

(57) The invention relates to an electrical igniter-fuse with an insulating support element (114, 214, 314, 414), carrying two contacts (128, 228, 328, 428; 130, 230, 330, 430) connected by an igniter bridge (132, 232, 332, 432). The igniter bridge (132, 232, 332, 432) consists of titanium or titanium nitride. This material causes a particularly good heat coupling in the igniter charge.



Description

The invention relates to an electrical igniter/fuse with an insulating support element carrying contacts connected by an igniter bridge.

Explosives are frequently used in mining and construction to loosen or move rock. Electrical primers are used in this case, in order to initiate the detonation from a safe distance. Generally, several explosive charges are detonated simultaneously in such detonations, in order to cause the desired pressure distribution in the rock or controlled collapse during demolition of buildings. Since firing failures adversely affect pressure distribution and can lead to uncontrolled collapse, the primers must possess high reliability with respect to defective function.

Igniters are also used as flame-forming elements, in order to ignite pyrotechnic materials, such as propellant powders for cartridges or gas-generating mixtures. High reliability against defective function is also essential here.

DE-PS 20 20 016 describes an electrical primer with an electrically conducting housing, a pole piece arranged insulated in it and accessible from the outside, which is connected in an electrically conducting manner to the housing only through an igniter bridge, and a primer charge. The igniter bridge lies as a metal layer on the side of the insulator facing the primer charge, and it is provided with contacts. The contacts consist of nickel, palladium, palladium-silver, palladium-gold, platinum-gold, platinum-silver, or silver-aluminum alloys. The igniter bridge connecting the contacts consists of tantalum or tantalum nitride and is applied to the support element by cathode spattering or evaporation in high vacuum. The exact shape of the igniter bridge is produced by a photo-etching technique or by another mask technique. To ignite the primer, a voltage is applied, so that an ignition current flows between the contacts and over the igniter bridge. This ignition current heats the igniter bridge, so that the primer detonates the explosive charge.

A primer described in EP 0 120 176 B1 also has an insulating support element, a conducting pole element, as well as a conducting housing. However, it does not have its own primer charge. A conducting metal layer is applied to the insulating support element, which has an almost circular recess, so that an internal area of the conducting layer is connected to an outer area of the conducting layer only through an igniter bridge. The conducting layer is constructed from one or more individual metal layers, in which an adhesive layer consists of chromium-nickel alloy and the actual pure conducting layer consists of gold, pure nickel, chromium, aluminum, palladium or alloys.

The underlying task of the invention is to provide a cost-effective primer that is reliable with respect to its ignition behavior.

The solution to this task occurs according to the invention with the features of Claim 1.

In the invention, the igniter bridge connecting the contacts applied to the insulating support element consists of titanium, titanium nitride, or an alloy containing mostly titanium. It has been found that the use of titanium or titanium nitride causes a wide igniter-bridge burn-through, because of its high heat conductivity, so that the heat required to ignite the primer charge is introduced over a large surface area into a large

number of primer-charge crystals. Very good adaptation of thermal coupling between the primer charge and the igniter bridge therefore exists with titanium or titanium nitride.

Since titanium and titanium nitride have higher electrical resistivity than the previously used igniter-bridge materials, the igniter bridge can have a larger layer thickness and greater cross-section when titanium or titanium nitride is used than with the use of known materials, in order to arrive at an igniter bridge with the same resistance.

The larger cross-section makes it possible to provide the heating igniter bridge with a larger surface. Because of this, heat coupling is improved. An igniter bridge with a larger cross-section is also easier to produce, and also permits easier adjustment of the resistance of the igniter bridge. The larger layer thickness also produces improved mechanical properties of an igniter bridge, and the igniter bridge is therefore less sensitive to scratches and abrasion.

In a preferred embodiment, the contacts also consist of titanium or an alloy containing mostly titanium. The contacts are large in area and are designed as a thick layer of more than 1 μm, in order to have only low electrical resistance. The exclusive use of titanium as base material, both for the igniter bridge and for the contacts, simplifies production of the primer relative to known multilayer techniques. Since the contacts are provided over a large area, an undesired rise in electrical resistance of the feed line to the igniter bridge is avoided.

Four embodiment examples of the invention are in more detail explained below, with reference to the drawings.

In the drawings:

Fig. 1 shows a first embodiment of an electrical igniter/fuse in cross-section,

Fig. 2 shows the electrical igniter/fuse according to the first embodiment, in a cross- section along line II-II in Fig 1,

Fig. 3 shows a second embodiment of the electrical fuse/igniter in cross-section,

Fig. 4 shows the electrical igniter/fuse according to the second embodiment in a cross-section along line IV-IV in Fig. 3,

Fig. 5 shows a third embodiment of the electrical igniter/fuse in cross-section,

Fig. 6 shows the igniter/fuse according to the third embodiment in a cross-section along line VI-VI in Fig. 5,

Fig. 7 shows a fourth embodimentof the electrical igniter/fuse in cross-section, and

Fig. 8 shows the electrical igniter/fuse according to the fourth embodiment in a cross-section along line VIII-VIII in Fig. 7.

An electrical igniter/fuse **110** depicted in Fig. 1 has a housing **112**, which is closed on its lower end with an insulating support element **114**. A pyrotechnic charge **116** is arranged in the interior of housing **112**, which consists of two different pyrotechnic materials **118**, **120**.

To ignite the igniter/fuse **110**, a metal layer **124** of titanium is evaporated onto the top **122** of the insulating support element **114** lying against the pyrotechnic charge **116**. The metal layer **124** is etched through linearly, so that an edge region **126** is formed that encloses a first contact **128** and a second contact **130**, which are connected to each other by an igniter bridge **132**.

The first and second contacts **128**, **130** are electrically connected to each other by the igniter bridge **132** and electrically insulated by an insulation zone **133** with respect to

edge region **126**. The igniter bridge **132** consists of an area of the metal layer **124** that was left between the first and second contacts **128, 130** during the etching of metal layer **124,** in which case contacts **128, 130** represent igniter-bridge connection surfaces.

The first contact **128** is connected to a first contact pin **134** extending through the insulating support element **114**, and the second contact **130** to a second contact pin **136** passing through the insulating support element **114**.

The insulating support element **114** is a circular disk made of ceramic, which is enclosed on its circumference by a metallic circular ring **138**. This circular ring **138** forms part of the housing **112** and has a flange directed radially outward on its bottom. A sleeve **140** forming another part of housing **112,** which has an annular axial protrusion **142** on its bottom, is mounted to fit onto the shoulder formed by circular ring **138** and flange **139**. The circular ring **138** and sleeve **140** have the same outside diameters and are welded to each other with a continuous seam. The inside diameter of sleeve **140**, however, is greater than that of circular ring **138**.

The metal layer **124**, consisting of titanium, partially overlaps the upper end of circular ring **138** with its end region. The first and second contacts **128, 130** are roughly rectangular in the top view and occupy about 25% of the surface of metal layer **124**. The distance between the two contacts **128, 130** is bridged by the igniter bridge **132**, whose length is defined by the distance between the two contacts. The width of the roughly rectangular igniter bridge in the top view is chosen so that the surface of the igniter bridge **132** encompasses about 2% of the surface of metal layer **124;** whereby the layer thickness of the evaporated metal layer **124** (or applied by cathode spattering) and therefore the igniter bridge **132** is greater than 1 μm. The resistance of the igniter bridge **132** is then determined by its cross-section, which is defined as the product of layer thickness and width of the igniter bridge **132**, as well as the length of the igniter bridge **132**. The resistance can be easily adapted to the corresponding requirements by selecting the width and length of the igniter bridge **132**.

The igniter/fuse **110** is ignited by applying a voltage to the first and second contact pins **134, 136**. Because of this, a current flows through the igniter bridge **132**, which is then heated and melted. In this manner, heat is coupled into the pyrotechnic material **120** lying over the entire surface on the igniter bridge **132**, so that ignition of the pyrotechnic charge **116** occurs.

In the second embodiment, the first contact **228** of the igniter/fuse **210** is formed so that it partially overlaps the circular ring **238** with its circular edge. The first contact **228** is also supported against sleeve **240**. In this manner, the first contact **228** is connected in an electrically conducting manner to housing **212**.

The third embodiment of the igniter/fuse **310** agrees with the first two embodiments with respect to configuration of housing **312**, insulting support element **314,** and pyrotechnic charge **316**. In contrast to the first two embodiments, however, the electrical igniter/fuse **310**, has only a first contact pin **334**, which passes through the insulating support element **314**. The contact pin **334** is arranged in the center of the insulating support element **314** and is connected in an electrically conducting manner to the first contact **328** on the top **322** of the insulating support element **314**. The first contact **328** occupies a circular surface of the metal layer **324**. The second contact **330** is formed by an annular surface enclosing the first contact **328**, which is separated from the first contact **328** only by a narrow insulation zone **333**. The second contact **330** overlaps

the metal circular ring **338** on its outer edge and is supported against sleeve **340**. The first and second contacts **328, 330** are connected by means of igniter bridge **332**, whose surface corresponds roughly to the igniter bridges of the first and second embodiment. The length of igniter bridge **332** is determined by the length of two parallel extensions **344, 346, which** extend outward from insulation zone **333**. The width of the igniter bridge **333** is equal to the spacings of extensions **344, 346**. The resistance of igniter bridge **332** can be adjusted with a fixed layer thickness of igniter bridge **332** by lengthening or shortening the extensions **344, 346** or by varying their spacing.

In order to ignite the igniter/fuse **310** according to the third embodiment, the housing **312** is connected to one pole and the first contact pin **334** to the other pole of a voltage source.

The fourth embodiment of the igniter/fuse **410,** depicted in Fig. 7 and 8, has a housing **412**, which is cup-shaped and has a circular perforation in the bottom **448** formed on its bottom. An assembly of an insulating support element **414**, two insulating elements **452, 454** and a pole shoe **456** is arranged in the interior of housing **412**.

The pole shoe **456** is a metallic, circular shell element, which has a protrusion **458** essentially with the shape of truncated cone arranged centrally on the bottom and tapering from the shell element, to which an electrical connection cable can be fastened by screws or clamps. The pole shoe **456** has a wall **459 that** borders an opening **460, which** tapers conically in the direction toward protrusion **458**. The pole shoe **456** is encapsulated on its circumference by insulation elements **452, 454** in the form of semi-shells. The insulation elements **452, 454** are shaped so that the wall **459** encloses the inner edge and the bottom **461** of pole shoe **456** in areas. The half-ring-shaped partial pieces **462, 464** that enclose the wall **459** on the inside then delimit a cylindrical free space between them.

The insulating support element **415** is a ceramic circular disk that has a hole **466** connecting its top and bottom **422, 423** in its center. The insulating support element **415** is provided with a layer of titanium or titanium nitride on its top and bottom **422, 423**, as well as on the wall of hole **466**. The first and second contacts **428, 430** are formed on the top **422** of insulating support element **414** by means of a laser cutting technique. The essentially circular insulation zone **433** between contacts **428, 430** produced with the layer determines, by its width, the spacing between the first and second contacts **428, 430** and therefore the length of igniter bridge **432**, which consists of the region of the metal layer **424** that was left in place and connects the two contacts **428, 430** in an electrically conducting manner. The insulating support element **414** is fit into the free space between the partial pieces **462, 464** in the form of half-rings, so that the metal layer situated on its bottom **423** is connected in a conducting manner with pole shoe **456**.

The assembly of the insulating support element **414**, the insulating element **452, 454** and the pole shoe **456** is inserted into the cup-shaped housing **412**, so that the insulating elements **452, 454** fit against the inside wall of housing **412**. The pole shoe **456** is then electrically insulated with respect to housing **412**. A contact cap **468**, which lies against the inside of housing **412** with its outer surface **470**, overlaps the outer edge of the second contact **430** with its bottom part **474**, having a central opening **472**. In this way, the housing **412** is connected in an electrically conducting manner to the second contact **430**.

The pyrotechnic charge **416** in this embodiment consists merely of a pyrotechnic material **418** that is filled into housing **412** from the top, in which case the remaining

internal part of housing **412**, and especially the central opening **472** of contact cap **468** are completely filled up. The primer charge **416** then lies over the entire surface of igniter bridge **432**. For ignition in this embodiment, one pole of the voltage source is connected to housing **412** and the other pole to the pole shoe **456**, so that electric current can flow from housing **412** through the contact cap **468** to the second contact **430** and from there, through the heating igniter bridge **432**, the first contact **428**, the metal layer in hole **466** and the bottom **423** of insulation support **412** to pole shoe **456**.

Patent claims

1. An electrical igniter/fuse with an insulating support element (**114, 214, 314, 414**) that carries two contacts (**128, 228, 328, 428; 130, 140, 320, 330, 430**) connected by an igniter bridge (**132, 232, 332, 432**), **characterized in** that the igniter bridge (**132, 232, 323, 432**) consists of titanium, titanium nitride, or an alloy containing mostly titanium.
2. An igniter/fuse according to Claim 1, characterized by the fact that the igniter bridge (**132, 232, 332, 432**) consists of technically pure titanium.
3. An igniter/fuse according to Claim 1 or 2, characterized by the fact that the contacts (**128, 228, 328, 428; 130, 230, 330, 430**) and the igniter bridge (**132, 232, 332, 432**) are formed in one piece and consist of the same material.
4. An igniter/fuse according to Claim 1 or 2, characterized by the fact that the contacts (**128, 228, 328, 428; 130, 230, 330, 430**) consist of a material that has a lower resistivity than titanium.

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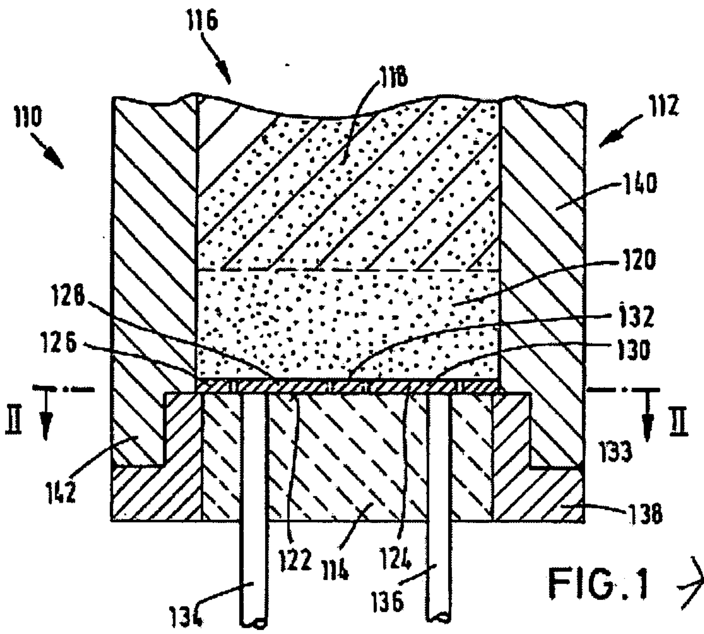


FIG. 1

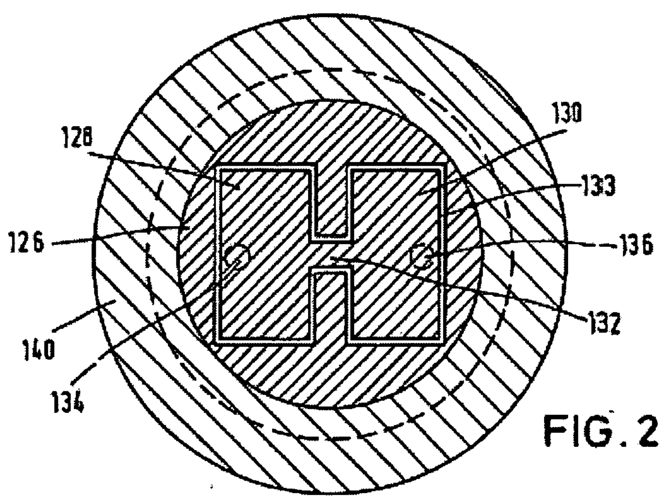


FIG. 2

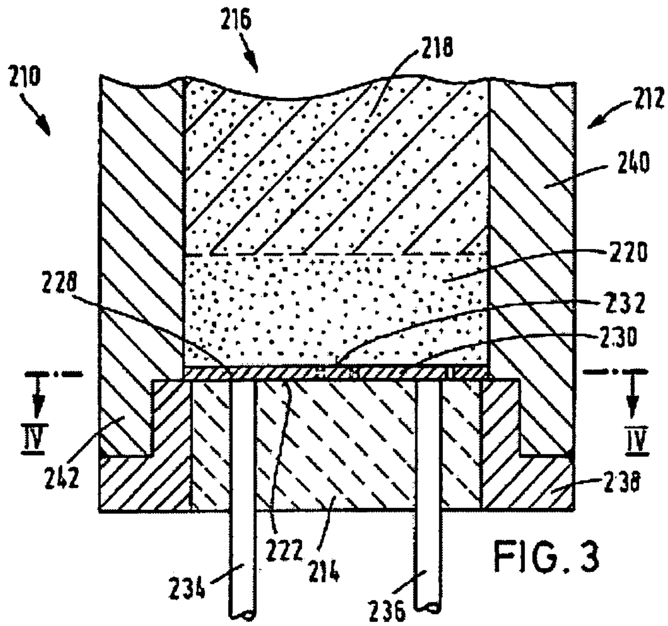

216
218
210
212
240
220
228
232
230
IV
IV
242
238
222
214
234
236

FIG. 3

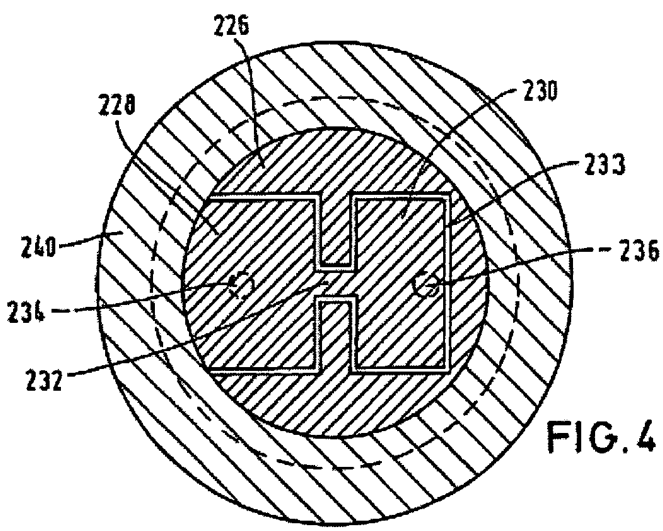
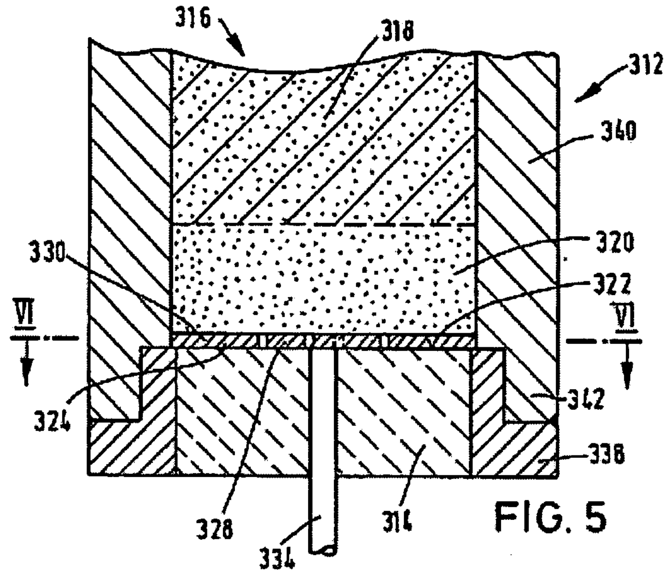
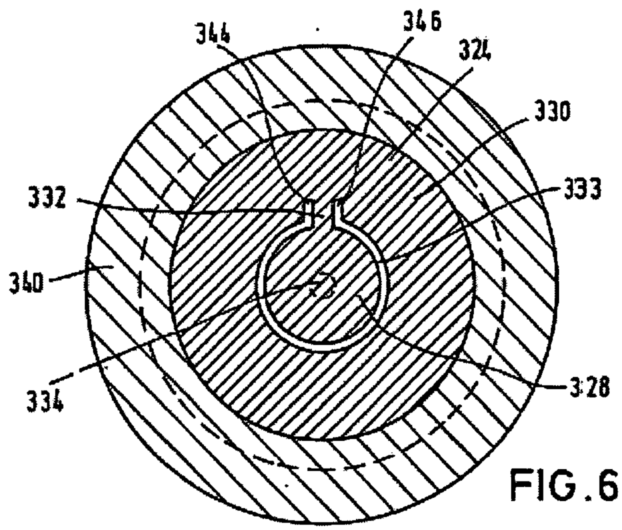

226
230
228
233
240
236
234
232

FIG. 4



316
318
312
340
330
320
322
VI
VI
324
342
338
328
314
334

FIG. 5



344
346
324
330
332
333
340
334
328

FIG. 6

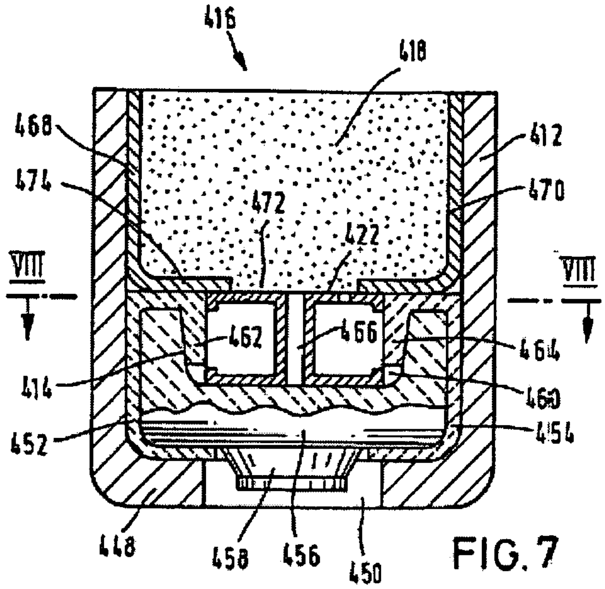

416
418
468
412
474
472
470
422
VIII
VIII
462
466
464
414
460
452
454
448
458
456
450

FIG. 7

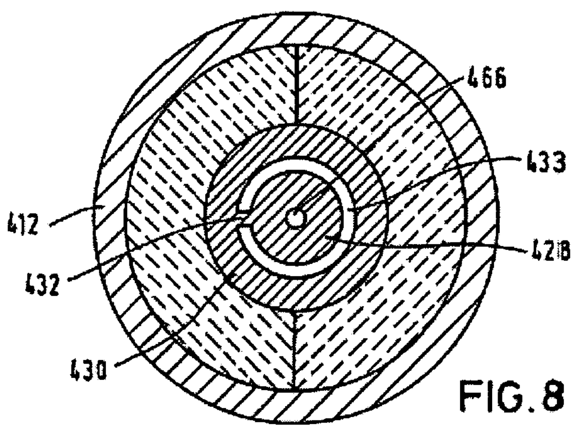

466
433
412
428
432
430

FIG. 8